

# (12) UK Patent Application (19) GB (11) 2 294 854 (13) A

(43) Date of A Publication 08.05.1996

(21) Application No 9422208.0

(22) Date of Filing 03.11.1994

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(51) INT CL<sup>6</sup>

**H04S 7/00**

(52) UK CL (Edition O )

**H4R RSVC R16A2**

(56) Documents Cited

**GB 2277239 A1**

**EP 0516183 A1**

**WO 91/13497 A**

**WO 88/02958 A**

(58) Field of Search

**UK CL (Edition N ) H4R RSAD RSVC RSX**

**INT CL<sup>6</sup> H04H , H04S**

**Online: WPI, EDOC, JAPIO, INSPEC**

(54) Audio signal processing

(57) An audio signal processing system in which a visual display is arranged to provide a visual representation (16) of a sound generating device (111) i.e. loud speakers, a notional listening position and a space in which a perceivable sound source may be located. A visual characteristic e.g. luminance, colour or saturation of the display space is modified so as to represent a characteristic relevant to the sound generating device when a perceivable sound source is located at respective positions within a displayed space. The visual characteristic may be modified in accordance with the amplification gain or response of one or more of the sound generating devices. The audio signal processing system may include (Fig. 1 not shown) a video disc storing video chips, an audio disk storing selectable sound tracks, and audio console for adjusting volume or tone, a graphic tablet for fixing the position of a sound source, video and audioscope displays, a processing unit, and audio interface and a plurality of speakers. The system enables easy setup and manipulation during operation of the system.

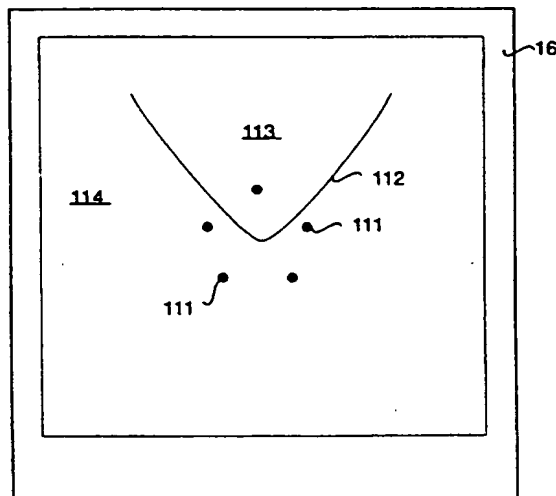


Figure 6

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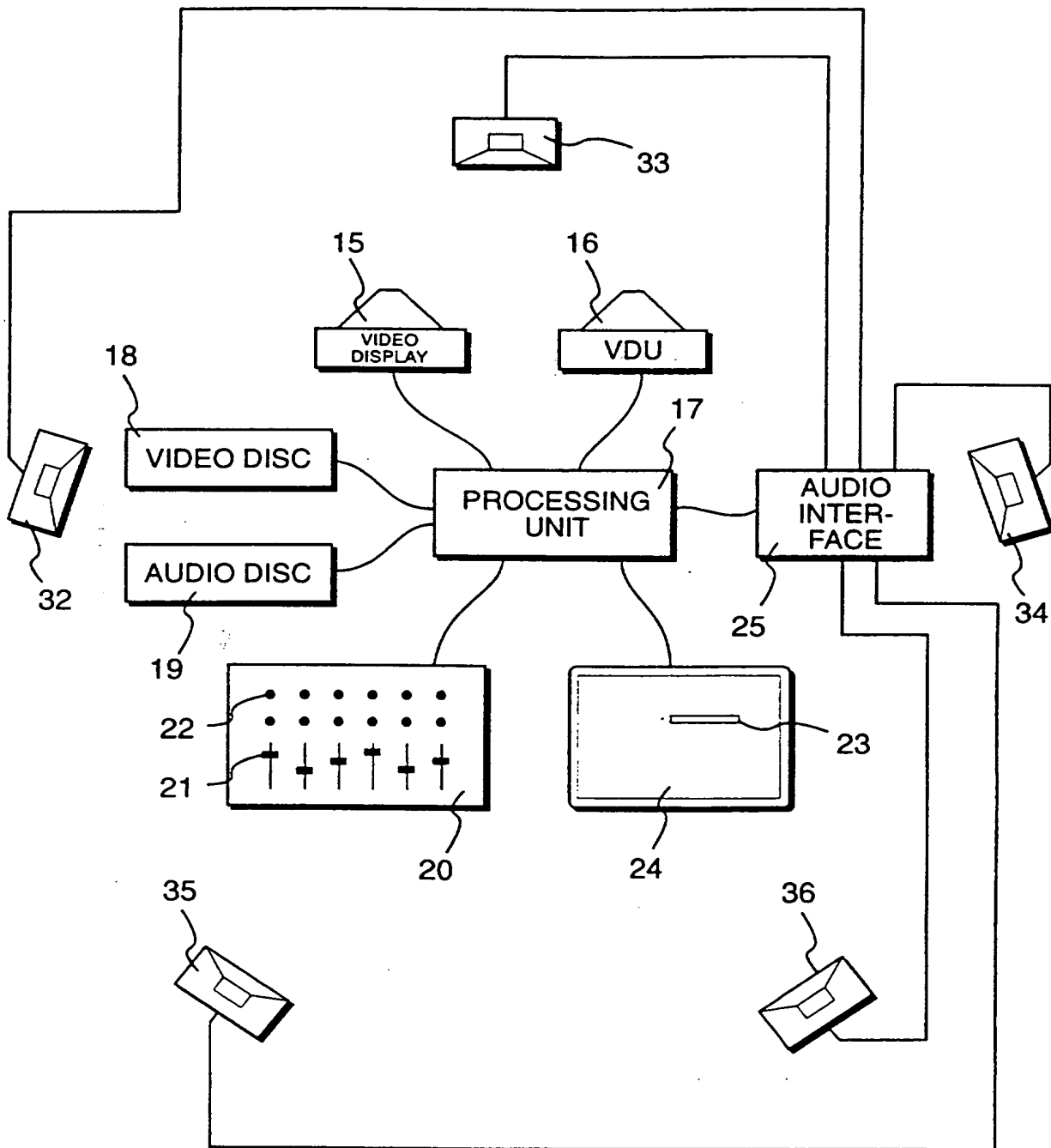


Figure 1

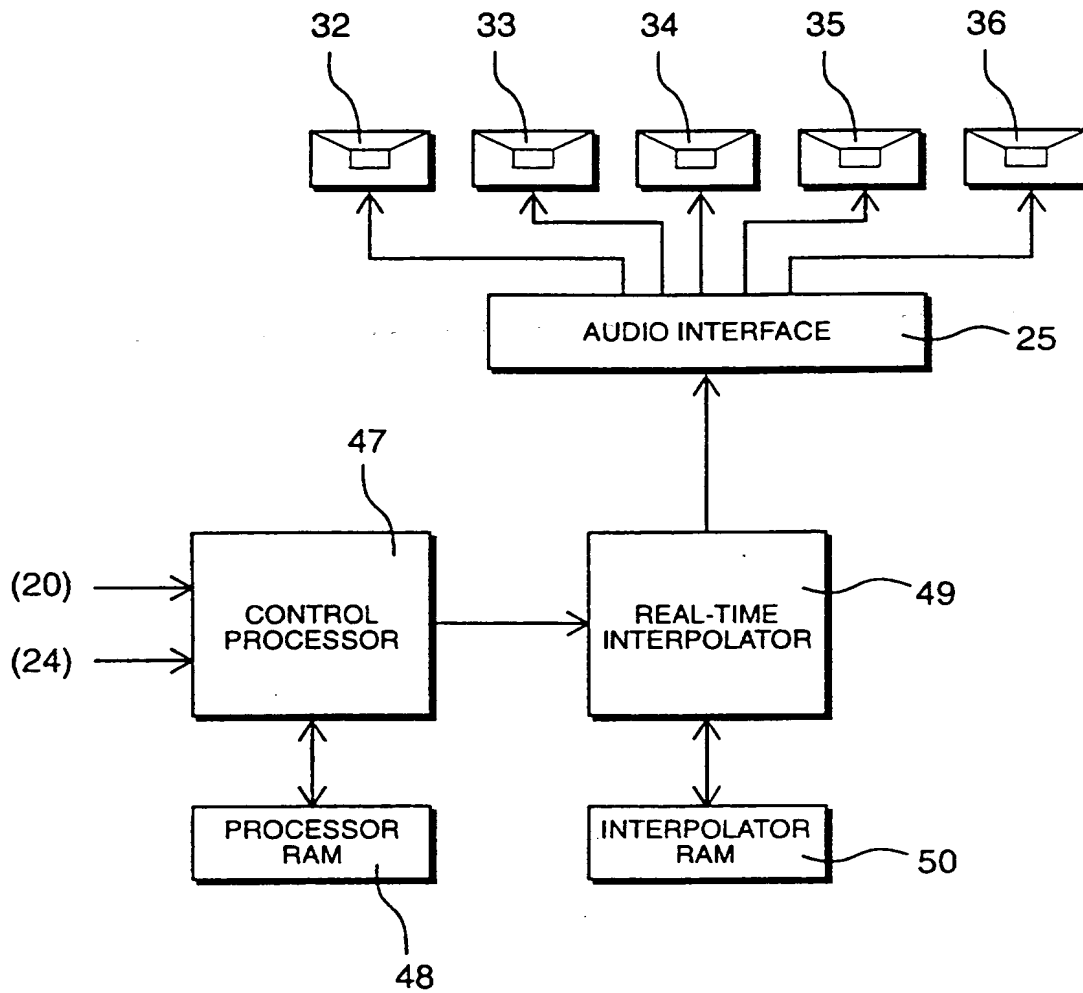


Figure 2

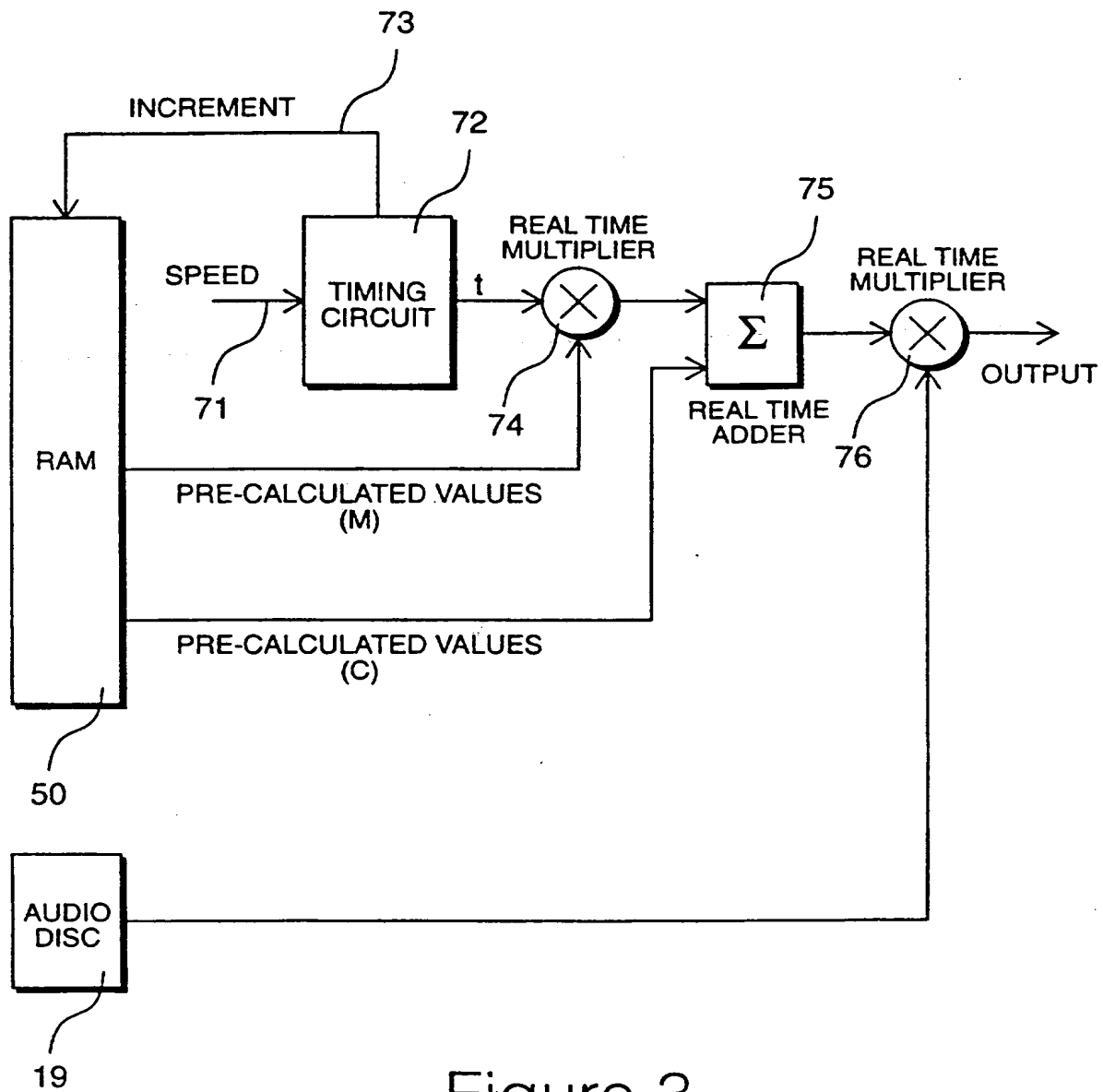


Figure 3

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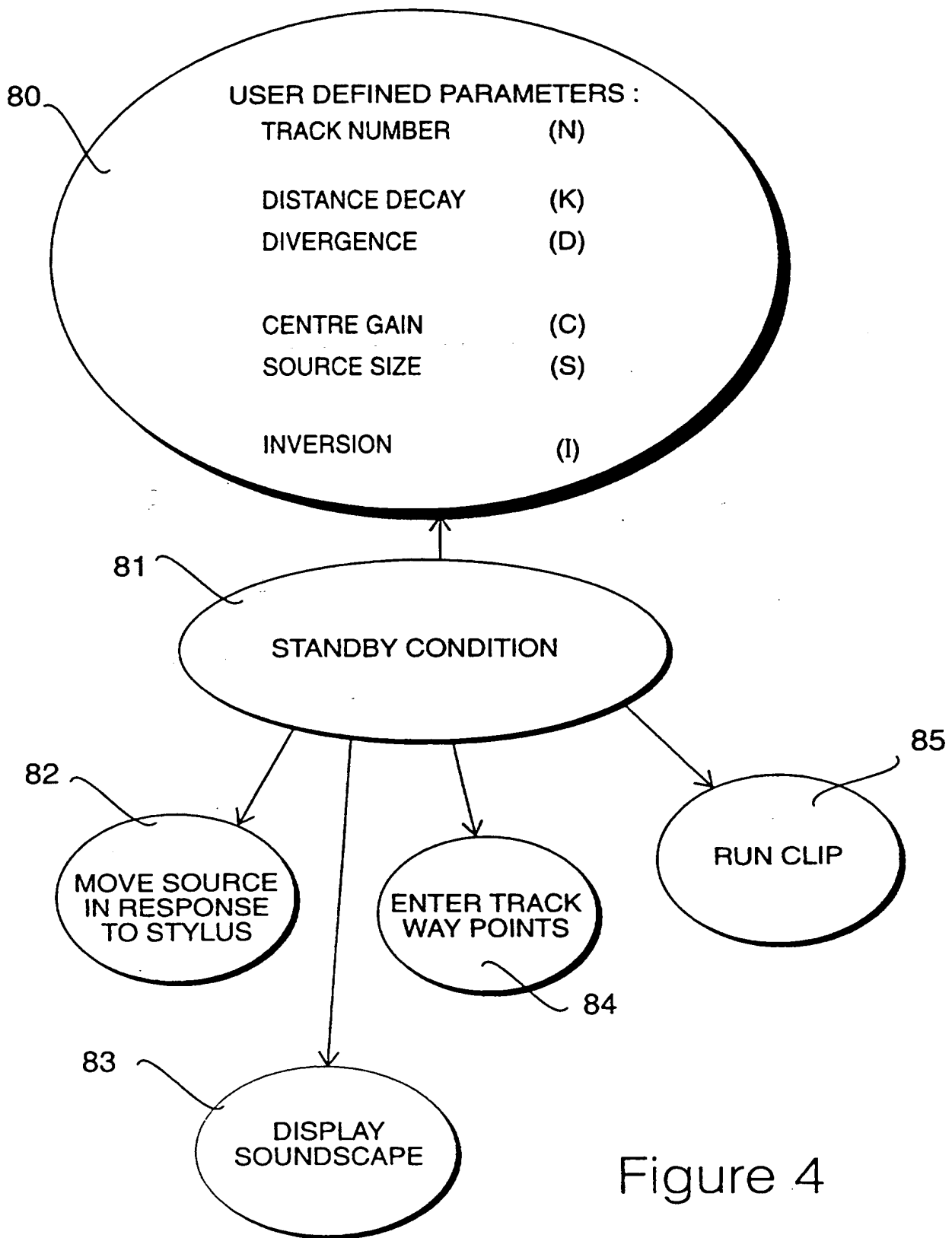


Figure 4

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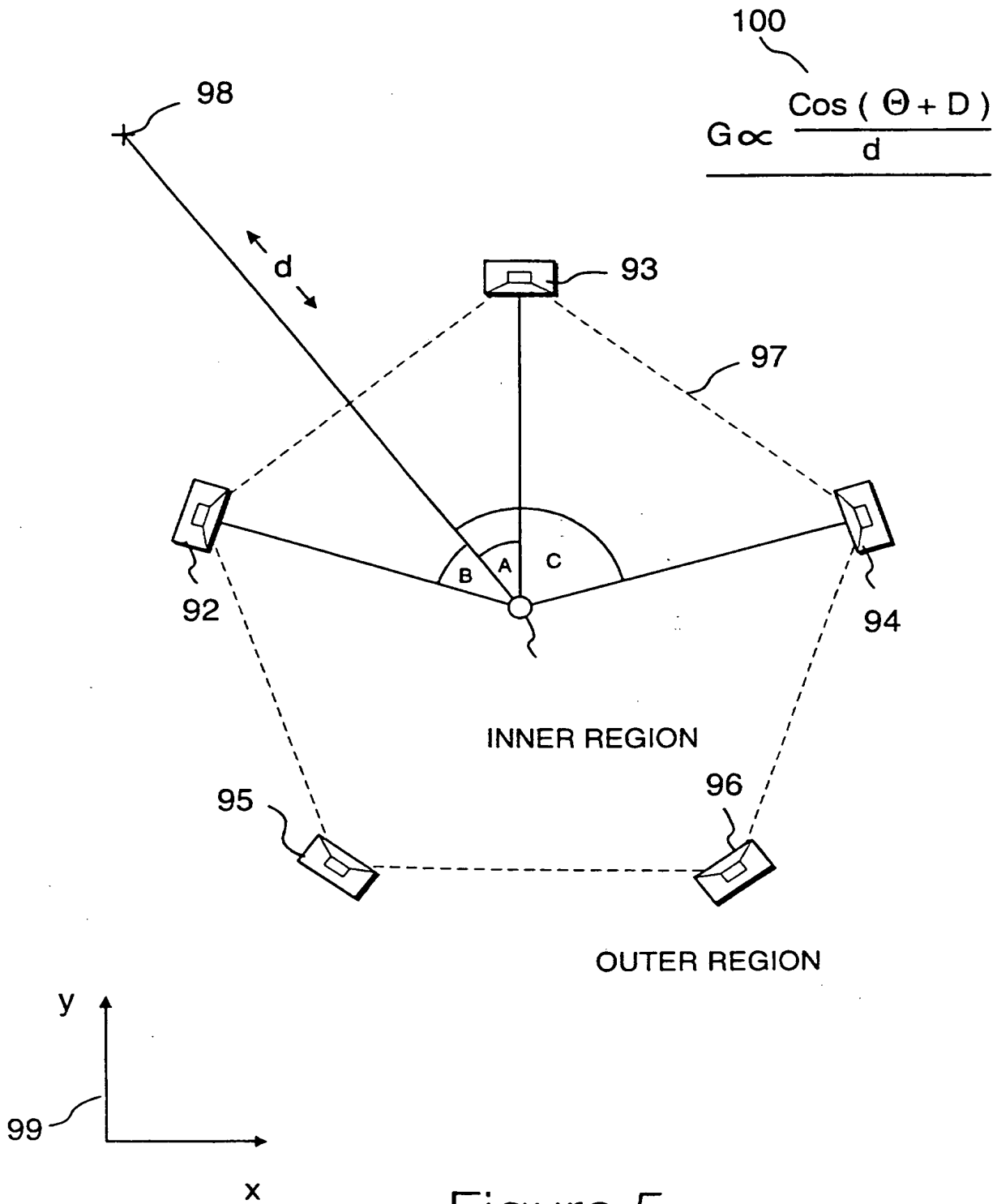


Figure 5

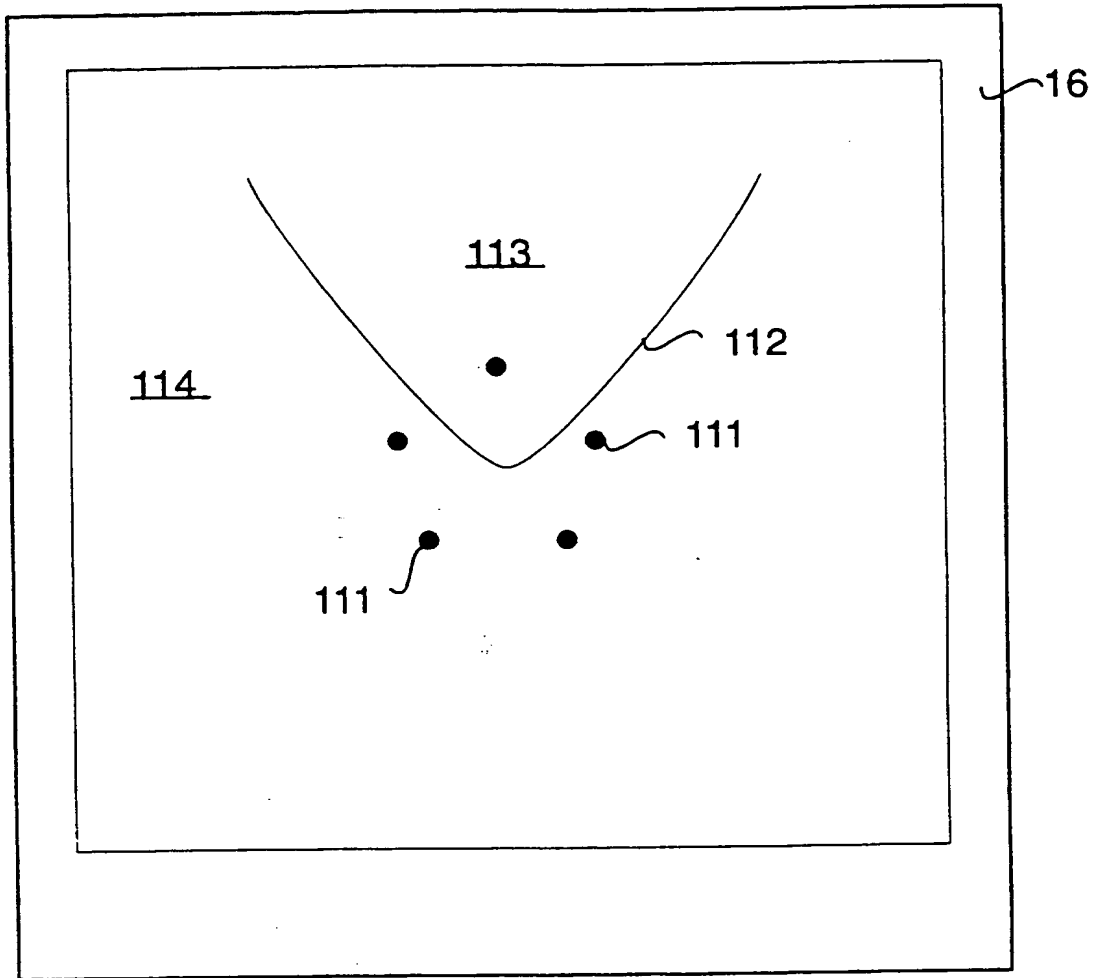


Figure 6

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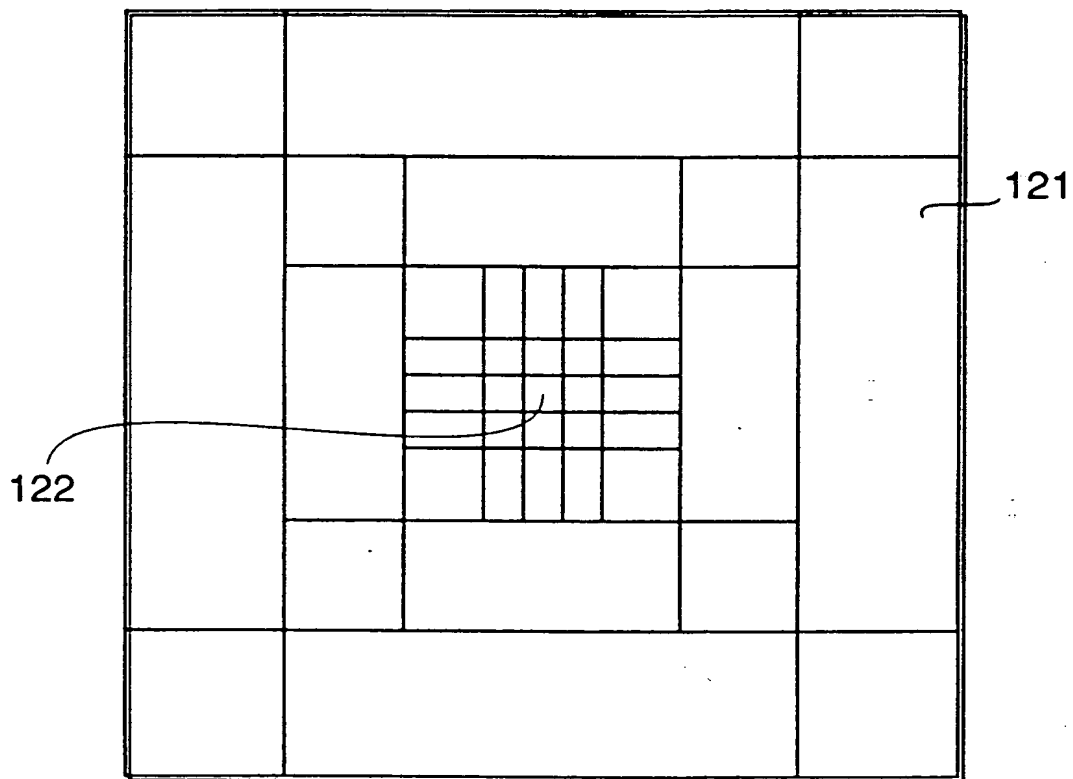


Figure 7



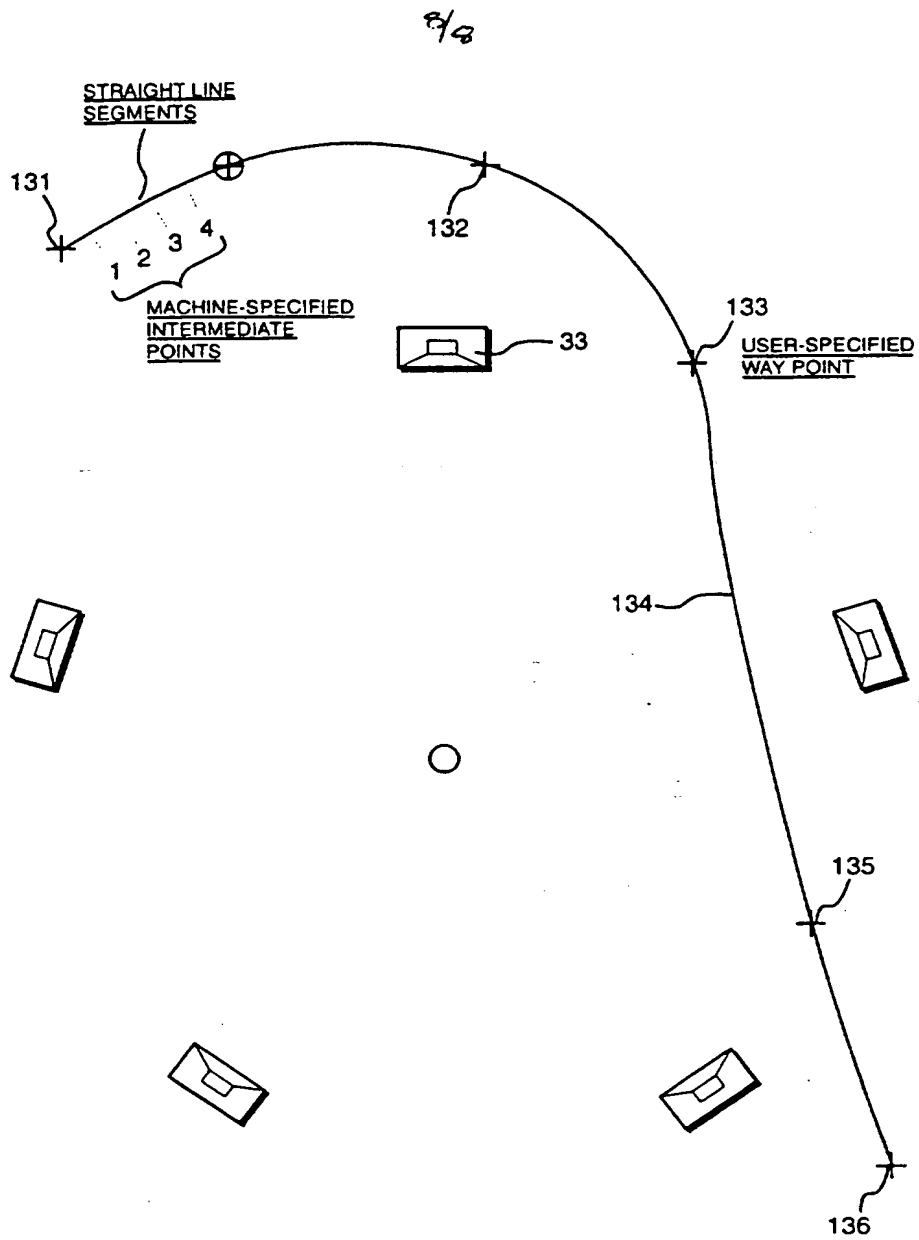


Figure 8

## AUDIO SIGNAL PROCESSING

The present invention relates to audio signal processing.

5 In particular, the present invention relates to audio signal processing, wherein a visual display is arranged to provide a visual representation of a sound generating device, a notional listening position and a space within which a perceivable sound source may be located.

10 A system for mixing five channel sound for an audio plane is disclosed in British Patent Publication 2 277 239. The position of a sound source is displayed on a VDU relative to the position of a notional listener. The sound sources are moved within the audio plane by operation of a stylus on a touch tablet, allowing an operator to specify positions of a sound source over time, whereafter a processing unit calculates gain values for the five channels at sample rate. Gain values are calculated for the track for each of the loudspeaker channels and for each of the specified points. Gain values are then produced at sample rate by interpolating  
15 calculated gain values for each channel at sample rate.

A system for processing, editing and mixing audio signals and for combining said audio signals with video signals, is shown in figure 1. Video images and overlaid video related information are displayable on a video monitor display 15, similar to a television monitor. In addition, a computer type visual display unit 16  
20 is arranged to display information relating to audio signals. Both displays 15 and 16 receive signals from a processing unit 17 which in turn receives compressed video data from a magnetic disc drive 18 and full bandwidth audio signals from an audio disc drive 19.

25 The audio signals are recorded in accordance with professional broadcast standards at a sampling rate of 48 Khz. Gain control is performed in the digital domain at full sample rate in real-time. Manual control is effected via a control panel 20, having manually operable sliders 21 and tone control knobs 22.

Information is also supplied via manual operation of a stylus 23 upon a touch tablet 24. Video data is stored on the video storage disc drive 18 in compressed form and said data is de-compressed in real-time for display on the video display monitor 15 at full video rate. The video information may be encoded as described in the applicants co-pending international Patent application published as WO 93/19467.

In addition to moving the position of the notional sound source with respect to time, it is also possible to adjust other parameters which will influence the overall effect. In particular, the previous system provided means for adjusting sound divergence, that is to say the spread of the sound over a plurality of positions. The previous system also allows a parameter referred to as distance decay to be adjusted, which, as the name suggests, effectively provides a scaling parameter, relating distance travelled over the display screen to perceived distance travelled by the notional sound source.

In the known system, adjustments are made to these parameters by adjusting soft sliders displayed on the VDU. With practice, an operator would become accustomed to these sliders and, for a given situation, would probably be able to make suitable adjustments. However, to a lay-operator, adjusting sliders does not provide a very intuitive interface, therefore a problem with the known system is that operators could experience difficulties in obtaining optimum settings of the available parameters.

According to a first aspect of the present invention, there is provided an audio signal processing apparatus, comprising visual display means arranged to provide a visual representation of a sound generating device, a notional listening position and a space within which a perceivable sound source may be located; and means for modifying a visual characteristic of said displayed space so as to represent a characteristic relevant to said sound generating device when a perceivable sound source is located at said selectable position.

Thus, in addition to being provided with sliders in order to allow adjustment of parameters, an operator may also be provided with a visual representation in which a visual characteristic of a displayed space is modified at selectable positions, so as to represent the relevant sound characteristic at that position.

5            Preferably, the displayed visual characteristic is responsive to amplification gain, therefore, at each point, the displayed characteristic represents gain levels of signals supplied to sound generating devices, such as loudspeakers.

10           In a preferred embodiment, the means for modifying the visual characteristic of the displayed space includes means for modifying luminance values for said displayed space. However, in alternative embodiments, other characteristics of the displayed space may be modified, such as colour or saturation etc. Preferably, when luminance is modified, loud positions are shown as bright areas and quiet positions are shown as dark areas.

15           Preferably, a plurality of sound generating devices are visually represented. Sound generating devices may be represented in any arrangement, mapping on to the arrangement of loudspeakers provided within a theatre or cinema etc. For example, the loudspeakers may be arranged in a pentagon in accordance with digital theatre sound (DTS) recommendations. However, it should be appreciated, that the invention is equally applicable to any other preferred sound format.

20           According to a second aspect of the present invention, there is provided a method of processing audio signals, comprising steps of providing a visual representation of a sound generating device, a notional listening position and space within which a perceivable sound source may be located; and modifying a visual characteristic of said displayed space so as to represent a characteristic relevant to  
25           said sound generating device when a perceivable sound source is located at respective positions in said displayed space.

Preferably, the modification to said characteristic is responsive to amplification gain and said visual characteristic may be the luminance of displayed picture elements.

5 In a preferred embodiment, the visual display is divided into a plurality of regions and said characteristic is calculated for each of said regions. Said regions may be of constant size however, preferably, said regions are smaller close to the position of the notional listener and increase in size at positions further away from said notional listener.

10 The invention will now be described by way of example only, with reference to the accompanying drawings, in which:

Figure 1 shows a system for mixing audio signals, including an audio mixing display, input devices and a processing unit;

Figure 2 details the processing unit shown in Figure 1, including a control processor and a real-time interpolator;

15 Figure 3 details operation of the real-time interpolator shown in Figure 2;

Figure 4 illustrates modes of operation available to an operator, under the control of the control processor shown in Figure 2;

Figure 5 illustrates a typical display as shown on the visual display unit identified in Figure 1.

20 Figure 6 shows a display for the visual display unit in Figure 1, generated in response to the soundscape selection illustrated in Figure 4, in which loudspeaker gains for particular selectable locations are identified by brightness levels at said

locations, in which regions of brightness modification vary depending upon the distance from the notional listener.

Figure 7 illustrates how modifiable regions are built up, each consisting of a plurality of pixel locations;

5           Figure 8 illustrates the entry of track way points, as identified in Figure 4, so as to create a sound effect;

10           The system shown in figure 1 provides audio mixing synchronised to video timecode. Original images are recorded on film or on full bandwidth video, with timecode, and are then converted to a compressed video format to facilitate the editing of audio signals against compressed frames having an equivalent timecode. The audio signals are synchronised to the time code during the audio editing process, thereby allowing the newly mixed audio to be accurately synchronised and combined with the original film or full-bandwidth video.

15           The audio channels are mixed such that a total of six output channels are generated, each stored in digital form on the audio storage disc drive 19. In accordance with convention, the six channels represent a front left channel, a front central channel, a front right channel, a left surround channel, a right surround channel and a boom channel. The boom channel stores low frequency components which, in the auditorium or cinema, are felt as much as they are heard. Thus, the boom channel is not directional and sound sources having direction are defined by  
20           the other five full-bandwidth channels.

25           The apparatus shown in figure 1 is arranged to control the notional position and movement of sound sources within a sound plane. The audio mixing display 16 is arranged to generate a display showing the spatial arrangement of sound generating devices such as loudspeakers. In addition to the speakers, the position of a notional listener is represented, along with the position of a notional sound source,

created by supplying contributions of an original sound source to a plurality of the loudspeakers.

The audio display 16 also displays menus, from which particular operations may be selected in response to operation of the stylus 23 upon the touch tablet 24. Movement of the stylus 23, while in proximity to the touch tablet 24, results in the generation of a cross-shaped cursor upon the VDU 16. Menu selection from the VDU 16 is made by placing the cursor over a menu box and thereafter placing the stylus into pressure. The fact that a particular menu item has been selected is identified to the operator by a change in colour of that item. Thus, for example, from the menu, an operation may be selected such as to allow the positioning of a sound source. Thereafter, as the stylus is moved over the touch tablet 24, the cross represents the position of a selected sound source and once a desired position has been located, the stylus may be placed into pressure again, resulting in a marker remaining in the selected position. Thus, operation of the stylus in this way effectively instructs the system to the effect that, at a specified point in time, relative to the video clip, a particular audio source is to be positioned at the specified point.

In operation, an operator selects a portion of a video clip for which sound is to be mixed. All available input sound data is written to the audio disc storage device 19, at full audio bandwidth, effectively providing randomly accessible sound clips to the operator. thus, after selecting a particular video clip, the operator may select audio clips to be added to the selected video clip. Once an audio clip has been selected, a fader 21 is used to control the overall loudness of the audio signal and other modifications to tone may be made via means of the tone controls 22.

By operating the stylus 23 upon the touch tablet 24, a menu selection is made to position the selected sound source within the audio plane. Thus, after making this selection, the VDU displays an image allowing the operator to position the sound source within the audio plane. On placing the stylus 23 into pressure, a

processing unit 17 is instructed to store that particular position in the audio plane, with reference to the selected sound source and the duration of the selected video clip; whereinafter gain values are generated when the video clip is displayed. Audio tracks are stored as digital samples and the manipulation of the audio data is effected within the digital domain. Consequently, in order to ensure that gain variations are made without introducing undesirable noise, it is necessary to control gain (by direct calculation or by interpolation) for each output channel at sample-rate definition. Furthermore, this control must also be effected for each originating track of audio information which, in the preferred embodiment, consists of thirty eight originating tracks of audio information. For each output signal, derived from each input channel, digital gain control signals must be generated at 48 Khz.

Movement of each sound source, derived from a respective track, is defined with respect to specified points, each of which define the position of the sound to a specified time. Some of these specified points are manually defined by a user and are referred to as "way" points. In addition, intermediate points are also automatically calculated and arranged such that an even period of time elapses between each of said intermediate points.

After points defining trajectory have been specified, gain values are calculated for the sound track for each of said loud speaker channels and for each of said specified points. Gain values are produced at sample rate for each channel of each track by interpolating the calculated gain values, thereby providing gain values at the required sample rate. A processing unit 17 receives input signals from control devices, such as the control panel 20 and touch tablet 24, and receives stored audio data from the audio disc storage device 19. The processing unit 17 supplies digital audio signals to an audio interface 25, which in turn generates five analog audio output signals to the five respective loudspeakers 32, 33, 34, 35 and 36.

The processing unit 17 is detailed in Figure 2 and includes a control processor 47 with its associated processor random access memory (RAM) 48, a real-



time interpolator 49 and its associated interpolation RAM 50. The control processor 47 is based on a motorola 68300 thirty-two bit floating point processor or a similar device, such as a Macintosh quadra or an intel 80486 processor. The control processor 47 is essentially concerned with processing non-real-time information, therefore its speed of operation is not critical to the real-time performance of the system; however it does affect the speed of response to operator instructions.

The control processor 47 oversees the overall operation of the system and the calculation of gain values is one of many tasks. The control processor calculates gain values associated with each specified point, consisting of user defined way points and calculated intermediate points. The trajectory of the sound source is approximated by straight lines connecting the specified points, thereby facilitating linear interpolation performed by the real-time interpolator 49.

Sample points on linearly interpolated lines have gain values which are calculated in response to a straight line equation,  $g=mt+c$ . During real-time operation, values for  $t$  are generated by a clock in real-time and precalculated values for the interpolation equation parameters ( $m$  and  $c$ ) are read from storage. Thus equation parameters are supplied to the real-time interpolator 49 from the control processor 47 and written to the interpolator's RAM 50. Such a transfer of data is effected under the control of the processor 47, which perceives RAM 50 (associated with the real-time interpolator) as part of its own addressable RAM, thereby enabling the control processor to access the interpolator RAM 50 directly. Consequently, the real-time interpolator 49 is a purpose built device having a minimal number of fast real-time components.

The control processor 47 provides an interactive environment under which a user may adjust the trajectory of a sound source and modify other parameters associated with sound sources stored within the system. Thereafter, the control processor 47 is required to effect non-real-time processing of signals in order to update the interpolator's RAM 50 for subsequent use during real-time interpolation.

The control processor 47 present a menu to an operator, allowing operators to select a particular audio track and to adjust parameters associated with that track. Thereafter, the trajectory of a sound source is defined by the interactive modification of way points.

5           The real-time interpolator 49 is shown in Figure 3, connected to its associated interpolator RAM 50 and audio disk 19. When the real-time interpolator is activated in order to run a clip, a speed signal is supplied to a speed input 71 of a timing circuit 72. The timing circuit supplies a parameter increment signal to RAM 50 of increment line 73, to ensure that the correct address is supplied to the  
10       RAM for addressing the pre-calculated values for m and c. In addition, the timing circuit 72 also generates values of t, from which the interpolated values are derived.

Movement of the sound source is initiated from a particular point, therefore the first gain value is known. In order to calculate the next gain value, a pre-calculated value for m is read from the RAM 50 and supplied to a real-time  
15       multiplier 74. The real-time multiplier 74 forms a product of m and t, whereafter said product is supplied to a real-time adder 75. At said real-time adder 75 the output from the multiplier 74 is added to the relevant pre-calculated value for c, resulting in a sum which is supplied to a second real-time multiplier 76. At the second real-time multiplier 76 the product is formed between the output of real-time  
20       adder 75 and the associated audio sample, read from the audio disk 19.

          Audio samples are produced at a sample rate of forty-eight kilohertz and it is necessary for the real-time interpolator to generate five channels worth of digital audio signals at this sample rate. In addition, it is necessary for the real-time interpolator to effect this for all of the thirty-eight recorded tracks. In order to  
25       achieve this level of calculation, the devices shown in Figure 7 are consistent with the IEEE 754 thirty-two bit floating point protocol, capable of calculating at an effective rate of twenty million floating point operations per second.

Under control of the control processor 47, the system is capable of operating in a plurality of modes, as illustrated in Figure 4. Thus, from an initial standby condition 81, it is possible for a user to define parameters, as identified by operational condition 82. In addition, it is possible for the stylus 23 to be moved over the touch tablet 24 while listening to a particular input sound source, resulting in the notional sound position being moved interactively in response to movement of the stylus, as indicated by condition 82.

Condition 83 creates a display of what may be referred to as a soundscape. The adjustment of parameters under condition 82 changes the way in which a sound is perceived as it is positioned within the space displayed on the display unit 16. Thus the visual display 16 provides a visual representation of the sound generating loudspeakers, a notional listening position and a space within which the perceived sound source may be located. The processing unit, when operating under condition 83, modifies a visual characteristic of the displayed space at selectable positions so as to represent a characteristic relevant to sound generating devices when the perceived sound source is located at said selectable positions. Thus, when the notional sound source is placed at a particular location, the gain for a particular loudspeaker will be adjusted so as to create the impression that the sound source is perceived as being at that location. Thus, the gain of any particular loudspeaker will vary depending upon the position of the sound source. Furthermore, the actual relationship between position and gain will also depend upon the parameters specified at condition 82, particularly, the parameters specifying distance decay, divergence, centre gain and the source size.

The visual display unit 16 is arranged to visually represent the way in which the gain characteristic varies with respect to selectable positions. In a preferred embodiment, luminance values are modified so as to represent the gain invoked for the selected position. This gain may be displayed with respect to a single loudspeaker or, alternatively, a plurality of loudspeakers, possibly all of the loudspeakers, may be combined so as to give an indication, in terms of displayed

luminances, of the gain contributions at any particular selected point. Thus, when all of the loudspeakers have been selected, the luminance at any particular point will represent gain value contributions from all of the available loudspeakers. In this way, an operator is presented with a picture showing the overall nature of the soundscape, thereby allowing interactive modification of the user defined parameters.

After the soundscape has been specified under condition 83, an operator may enter track way points at condition 84, thereby defining the movement of the notional sound source over time, within an identified video clip.

Thereafter, condition 85 may be selected, providing for a selected clip to run. During the running of a clip, interpolated gain values are calculated in real-time, thereby the effect may be presented to an operator in real-time and recorded, if required, in real-time.

When moving the source in response to operation of the stylus, calculating luminance values for the soundscape or running a clip, it is necessary to calculate gain values for each sound generating loudspeaker. In order to achieve this, it is necessary to calculate gain values for loudspeakers as a function of the position of the notional sound source, in addition to user defined parameters.

An arrangement of loudspeakers similar to that displayed on the visual display unit 16, is illustrated in Figure 5. The loudspeaker positions are identified by icons 92, 93, 94, 95 and 96, which map onto physical loudspeakers 32, 33, 34, 35 and 36 of Figure 1 respectively. A pentagonal outline 97 connects the speakers and effectively provides a boundary between an inner region, bounded by the loudspeaker positions and an outer region, external to said loudspeaker positions.

A notional sound source position is identified by cursor 98. The position of this sound source is selectable by the operator, by operation of the stylus 23 upon

the touch tablet 24. Thus, by operation in this way, the cursor 98 has been placed at this position shown in Figure 5.

Images displayed on the visual display unit 16 are created by reading video information from a frame store at video rate. The frame store is addressed in order to identify locations within it, therefore any position within the frame of reference under consideration has a direct mapping to a location within the frame store. Thus, each position shown within Figure 5 may be identified with respect to a co-ordinate frame of reference, giving it a cartesian location specified by x and y coordinates, as represented by the x and y axes 99.

In order for a gain value to be calculated for a particular loudspeaker, it is necessary for reference to be made to a function relating the co-ordinate location of the notional sound source to the position of the notional listener and the position of the loudspeaker. A function of this type is illustrated generally at 100 in Figure 5. Thus, the gain is given as being proportional to the cosine of the angle between the position of the notional sound source and the position of the loudspeaker under consideration with respect to the position of the notional listener. Thus, when considering loudspeaker 93, the relevant angle is angle A as illustrated in Figure 5. Similarly, angle B will be relevant for loudspeaker 92 and angle c relevant for loudspeaker 94.

It is possible for an operator to specify a divergence, defining the spread of the source, therefore the divergence value is added to the angle theta and the cosine of this sum is divided by the distance d between the notional listener and the sound source. The position of the sound source is known, in terms of Cartesian coordinates, in addition to the position of the notional listener, in similar coordinates, thereby allowing the distance d to be calculated as a vector between these two points.

Other equations may be implemented for the calculation of gain values and the equation shown in Figure 5 is merely illustrative.

5 VDU 16 is shown in Figure 6, displaying an image of the type provided when the display soundscape condition 83 has been selected. The loudspeaker positions have been identified by dots 111 and an image has been selected which represents a gain distribution relevant to the front central loudspeaker. A gain contour 112 is shown, which may be considered as forming a boundary between an internal region 113 and external regions 114.

10 When a notional sound source position is located within region 113, positive gain signals will be generated for the front central loudspeaker, resulting in the output from said front central loudspeaker containing a contribution from the sound source under consideration. However, if the notional sound source position is located within region 114, the gain contribution to the front central loudspeaker is zero and the sound is presented to the notional listener as contributions from some  
15 or all of the remaining loudspeakers.

Within region 113 the gain generated for the front central loudspeaker does not remain constant and, in order to simulate the position of the notional sound source, a range of gain values will be calculated in accordance with a gain law, such as that suggested by equation 100 in Figure-5.

20 The video image displayed on monitor 16, during the soundscape operation, is derived from a full colour video frame store such that, under the control of the control processor 47, values may be written to said frame store, resulting in particular output colours being shown on the monitor. Under the "display soundscape" operation, the background colour is set to a particular hue, for example,  
25 it may be set to a representation of a blue hue, distinctive from other colours used for other modes of operation. Having set the hue it is now possible for the processor 47 to adjust other parameters, such as luminance for particular pixel

locations. Thus, within region 113, the luminance of pixel values is mapped onto gain values for the front central loudspeaker. Thus, at particular locations the gain for the loudspeaker will be relatively high, resulting in a relatively high luminance value being written to the corresponding position within the frame store. Similarly, at positions where the calculated gain is relatively low, suitably scaled luminance values are written to these appropriate positions within the frame store. Thus, a soundscape is generated showing how gain values for the loudspeaker under consideration vary, as a graphical representation, with respect to the position of the notional sound source.

In Figure 6 a representation has been produced for one loudspeaker. However, for any particular setup, it is possible to calculate gain contributions for all of the loudspeakers and to combine the luminance specified gain values concurrently. Thus, a video image is generated showing how gain values, and consequently overall loudness, varies as a notional object is moved within the soundscape. In this way, it is possible for an operator to make modifications to user defined parameters, in response to which variations occur to the displayed soundscape. In this way, parameters may be modified interactively, enabling an operator to define a soundscape for a particular application, without requiring detailed knowledge of the way in which the parameters modify the calculation of gain values.

The calculation of gain values for each pixel position within the frame store (the frame store consisting of, for example, approximately 700 x 500 pixel locations) would require a significant computational overhead.

There is no reason, in principle, why it would not be possible to calculate gain values for each loudspeaker and for each pixel location. However, in practice, this would require a significant computational overhead which would not be justified by the final outcome.

In order to optimise the calculation of gain values for graphical display, the frame store is divided into a plurality of regions as shown in Figure 7. The regions are arranged such that they effectively increase in size when moving away from the central location. Close to the position of the notional listener variations tend to occur rapidly as the available loudspeakers exchange responsibility for generating the notional sound source. However, as the notional sound source moves further away from the position of the notional listener, its contributions will tend to be derived from similar loudspeaker sources, therefore the information content diminishes.

As shown in Figure 7, the notional screen area is divided into a plurality of regions wherein one gain value is calculated per region. Towards the central position of the notional listener, region 122 may comprise a total of four pixel locations. Thus, in this central region, a separate gain value is calculated for each group of four pixel positions. As the selected location moves out from the position of the notional listener, the regions get progressively larger. Thus, towards the periphery of the visual display, regions may comprise one hundred pixel locations in 10 x 10 blocks.

Referring to Figure 4, once a soundscape has been displayed in accordance with operation 83, an operator may return to condition 82 and make modifications to defines parameters. The soundscape gives the operator an indication as to how the sound will be processed when a particular location has been selected. After obtaining the desired soundscape, the operator may select condition 84, under which way points are entered.

Manual selection via the VDU 16 is made by placing a cross over a menu box and placing the stylus into pressure. The fact that a particular menu item has been selected is identified to the operator via a changing colour of that item. Thus, from the menu, an operator may select operation 84 and thereafter position the sound anywhere within the available space for any point in time.



The stylus is moved over the touch tablet 24 resulting in cross 37 representing the position of the selected sound source. Once the desired position has been located, the stylus is placed into pressure and a marker thereafter remains at the selected position. This operation effectively creates data to the effect that, at a specified point in time, relative to the video clip, particular audio source is to be positioned at the specified point and a time code location may be specified by operation of a keyboard or similar device.

Thus, it is necessary for an operator to select a portion of a video clip for which sound is to be mixed. Input sound data is written to the audio disk storage device 19, at full audio bandwidth, thereby making the audio sound track randomly accessible to the operator. After selecting a particular video clip the operator is then in a position to select an audio signal which is to be edited with the selected video. Slider 21 is used to control the overall loudness of the audio signal and modifications to the tone of the signal are made using tone controls 22.

As shown in Figure 8, a user may specify way points 131, 132, 133, 134, 135 and 136. These selected points are connected by a spline defined by an additional machine specified intermediate points, identified as 1, 2, 3 and 4 in Figure 8. During real-time operation, gain values are generated at sample rate by linear interpolation. Thus, line segments between the machine specified points in Figure 8 are effectively connected by straight lines.

The present invention facilitates the generation of information relating to the movement of sound in three-dimensional space or over a two-dimensional plane. Gain values or other audio-dependent values are calculated at specified locations over a plane and a visual characteristic is modified in order to show variations in these audio characteristics. Thus, in the present embodiment, variations in signal gain are shown as luminance variations although, as it will be appreciated, any audio characteristic which varies with respect to position may be displayed by

modifying any visually identifiable characteristic, such as colour or saturation etc.  
as an alternative to luminance.

**CLAIMS**

1. Audio signal processing apparatus, comprising  
visual display means arranged to provide a visual representation of a sound  
generating device, a notional listening position and a space within which a  
5 perceivable sound source may be located; and  
means for modifying a visual characteristic of said displayed space so as to  
represent a characteristic relevant to said sound generating device when a  
perceivable sound source is located at respective positions in said displayed space.
- 10 2. Apparatus according to claim 1, wherein said means for modifying  
a visual characteristic is responsive to the amplification gain used to create the  
perception of a sound source located at respective positions.
3. Apparatus according to claim 1 or claim 2, wherein said means for  
modifying said visual characteristic of said displayed space includes means for  
modifying luminance values for said displayed space.
- 15 4. Apparatus according to claim 3, wherein said means for modifying  
said luminance is arranged such that loud positions are shown as bright areas and  
quiet positions are shown as dark areas.
5. Apparatus according to any of claim 1 to 4, wherein a plurality of  
sound generating devices are visually represented.
- 20 6. Apparatus according to claim 5, wherein said means for modifying  
a visual characteristic modifies said characteristic in accordance with the response  
of a selected one of said sound generating devices.

7. Apparatus according to claim 5, wherein said means for modifying said visual characteristic modifies said characteristic in response to the combined effect of a plurality of the available sound generating devices.

5 8. Apparatus according to any of 1 to 7, including means for defining a track and means for displaying said track on said display means, representing the movement of a notional sound source over time, wherein  
said visual representation is modified locally as said notional sound source moves through selected regions.

10. 9. Apparatus according to claim 8, including means for effecting movement of the notional sound source in response to manual operation of a selection device.

10. Apparatus according to claim 8 or claim 9, including means for recording a movement track in response to operation of a manual selection device.

15 11. Apparatus according to any of claims 1 to 10, wherein said displayed space is divided into a plurality of regions and said characteristic is calculated for each of said regions.

12. Apparatus according to claim 11, wherein said regions are smaller close to the position of the notional listener and larger further away from the position of the notional listener.

20 13. A method of processing audio signals, comprising steps of providing a visual representation of a sound generating device, a notional listening position and a space within which a perceivable sound source may be located; and

modifying a visual characteristic of said displayed space so as to represent a characteristic relevant to said sound generating device when a perceivable sound source is located at respective positions in said displayed space.

5           14.     A method according to claim 13, wherein the modification to said visual characteristic is responsive to the amplification gain used to create the perception of a sound source located at respective positions.

          15.     A method according to claim 13 or claim 14, wherein the modification of said visual characteristic includes the modification of luminance values for the displayed space.

10           16.     A method according to claim 15, wherein loud positions are shown as bright areas and quiet positions are shown as dark areas.

          17.     A method according to any of claims 13 to 16, wherein a plurality of sound generating devices are visually represented.

15           18.     A method according to claim 17, wherein the visual characteristic is modified in accordance with the response of one of said selected sound generating devices.

          19.     A method according to claim 17, wherein the visual characteristic is modified in response to the combined effect of a plurality of the available sound generating device.

20           20.     A method according to any of claims 13 to 19, including defining a track specifying the movement of a notional sound source and displaying said track, wherein a visual representation is modified locally as said notional sound source moves through selected regions.

21. A method according to claim 20, wherein movement of the notional sound source is effected in response to manual operation of a manually operable device.

5 22. A method according to any of claims 13 to 21, wherein the visual display is divided into a plurality of regions and said characteristic is calculated for each of said regions.

23. A method according to claim 22, wherein said regions are smaller close to the position of the notional listener and increase in size at positions further away from said notional listener.

10 24. Audio signal processing apparatus substantially as herein described with reference to the accompanying figures.

25. A method of processing audio signals substantially as herein described with reference to figures 4, 6 and 7.



Application No: GB 9422208.0  
Claims searched: 1 to 25

Examiner: Mr. Sat Satkurunath  
Date of search: 30 March 1995

## Patents Act 1977 Search Report under Section 17

### Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:  
UK CI (Ed.N): H4R: RSVC, RSAD, RSX  
Int CI (Ed.6): H04H-007/00, H04S-003/00, H04H-007/00  
Other: Online: WPI, EDOC, JAPIO, INSPEC

### Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
Y	GB2277239 A (SOLID) - see especially figures 1 to 3	1, 5, 13, 17
Y	EP0516183 A1 (SANYO) - see especially figure 5 and lines 32 to 46 in column 6	1, 3-5, 13, 15-17
Y	WO91/13497 (VOYAGER) - see especially figures 1, 5a, 5b and lines 24 to 27 on page 16	1, 3, 5, 13, 15
Y	WO88/02958 (BURTON) - see especially figure 4 and lines 9 to 18	1, 13

X Document indicating lack of novelty or inventive step  
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A Document indicating technological background and/or state of the art.  
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